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EPA Guide for Infectious Waste Management

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EPA GUIDE

FOR

INFECTIOUS WASTE MANAGEMENT

U.S. Environmental Protection Agency
Office of Solid Waste
Washington, D.C. 20460

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The infectious waste document provides guidance on the management of infectious waste. The document presents the EPA perspective on acceptable infectious waste management practices. Topics include the definition of infectious waste and recommended practices for packaging, treatment, transportation, storage, and disposal of these wastes. The document also contains an updated summary of State requirements and regulations.

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NOTICE

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FOREWORD

The Resource Conservation and Recovery Act of 1976, as amended, requires EPA to develop and evaluate environmentally sound methods for management of solid waste. In addition, the Act requires EPA to establish a "cradle-to-grave" management system for solid wastes which are identified as hazardous.

Congress defined hazardous waste generally to mean "a solid waste, or combination of solid wastes, which because of its quantity, concentration, or physical, chemical, or infectious characteristics may (A) cause or significantly contribute to an increase in mortality or an increase in serious irreversible, or incapacitating reversible, illness; or (B) pose substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, or disposed of, or otherwise managed." (Solid wastes are defined in the statute as solids, liquids, and gases.)

As a first step in fulfilling the Congressional mandate to establish a hazardous waste management system, EPA published proposed regulations in the Federal Register on December 18, 1978, which included a proposed definition and treatment methods for infectious waste. During the public comment period for this rulemaking, EPA received approximately sixty comments which specifically addressed the infectious waste provisions of the proposed regulations.

On May 19, 1980, EPA published the first phase of the hazardous waste regulations. The Agency stated in the preamble to the regulations that the sections on infectious waste would be published

when work on treatment, storage, and disposal standards was completed. While the Agency has evaluated management techniques for infectious waste, considerable evidence that these wastes cause harm to human health and the environment is needed to support Federal rulemaking.

In response to numerous requests for technical information and guidance on infectious waste management, EPA published its findings in September 1982, as a guidance manual, the Draft Manual for Infectious Waste Management (SW-957). After consideration of comments on the Draft Manual, the Agency decided to revise and finalize the manual. An ad hoc working group consisting of a cross-section of health care professionals from government, academia, private industry, and trade associations (see acknowledgements) was convened to provide expertise and assistance. We believe that this guidance document represents environmentally sound practices for the handling, treatment, and disposal of infectious waste, and reflect current thinking and practices in infectious waste management.

It should be noted that this guidance document addresses the management of infectious waste solely from the perspective of problems posed by its infectious characteristics. Additional hazards which may be posed by these wastes (e.g., toxicity, ignitability, and radioactivity) are not within the scope of this publication. Because EPA is publishing this document only to refine the draft manual, recent issues such as acquired immunodeficiency syndrome (AIDS) and antineoplastic agents are not specifically addressed. We further acknowledge that new methods and technologies, other than those discussed in

this document, are available for treating infectious waste. EPA recommends that persons desiring to use these techniques make certain that these techniques provide effective treatment.

Requests for copies of this document should be directed to Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20470, (202) 783-3238.

EXECUTIVE SUMMARY

The purpose of this document is to provide guidance on the management of infectious waste. The document presents the EPA perspective on acceptable infectious waste management practices. Discussions are limited to technologies that are typically and frequently used for treating and managing infectious waste; however, the EPA in no way intends to imply that alternative methods or new technologies are not available or acceptable.

EPA Recommendations for Infectious Waste Management

The EPA recommends that a responsible person or committee at the facility prepare an Infectious Waste Management Plan outlining policies and procedures for the management of infectious waste. This plan should include the following elements:

- Designation
- Segregation
- Packaging
- Storage
- Transport
- Treatment
- Disposal
- Contingency Planning
- Staff training

1. Designation of Infectious Waste

EPA recommends that the following categories of waste be designated as infectious waste:

Waste Category	Examples*
Isolation wastes	° refer to Centers for Disease Control (CDC), Guidelines for Isolation Precautions in Hospitals, July 1983
Cultures and stocks of infectious agents and associated biologicals	° specimens from medical and pathology laboratories ° cultures and stocks of infectious agents from clinical, research, and industrial laboratories; disposable culture dishes, and devices used to transfer, inoculate and mix cultures ° wastes from production of biologicals ° discarded live and attenuated vaccines
Human blood and blood products	° waste blood, serum, plasma, and blood products
Pathological waste	° tissues, organs, body parts, blood, and body fluids removed during surgery, autopsy, and biopsy
Contaminated sharps	° contaminated hypodermic needles, syringes, scalpel blades, pasteur pipettes, and broken glass
Contaminated animal carcasses, body parts, and bedding	° contaminated animal carcasses, body parts, and bedding of animals that were intentionally exposed to pathogens

*These materials are examples of wastes covered by each category. The categories are not limited to these materials.

The EPA has identified an optional infectious waste category which consists of miscellaneous contaminated wastes. While there is not a unanimity of opinion regarding the hazards posed by these wastes, EPA believes that the decision whether to handle these wastes as "infectious" should be made by a responsible authorized person or committee at the individual facility. However, the Agency recommends that wastes from patients known to be infected with blood-borne diseases should be managed as infectious waste (for example, dialysis waste from known hepatitis B patients).

Miscellaneous Contaminated Wastes	Examples
Wastes from surgery and autopsy	° soiled dressings, sponges, drapes, lavage tubes, drainage sets, underpads, and surgical gloves
Miscellaneous laboratory wastes	° specimen containers, slides, and cover slips; disposable gloves, lab coats, and aprons
Dialysis unit wastes	° tubing, filters, disposable sheets, towels, gloves, aprons, and lab coats
Contaminated equipment	° equipment used in patient care, medical laboratories, research, and in the production and testing of certain pharmaceuticals

II. Segregation of Infectious Waste

EPA recommends:

- segregation of infectious waste at the point of origin
- segregation of infectious waste with multiple hazards as necessary for management and treatment
- use of distinctive, clearly marked containers or plastic bags for infectious waste
- use of the universal biological hazard symbol on infectious waste containers, as appropriate

III. Packaging of Infectious Waste

EPA recommends:

- selection of packaging materials that are appropriate for the type of waste:
  - plastic bags for many types of solid or semi-solid infectious waste
  - puncture-resistant containers for sharps
  - bottles, flasks, or tanks for liquids
- use of packaging that maintains its integrity during storage and transport
- use of plastic bags that are impervious, tear resistant, and distinctive in color or markings
- closing the top of each bag by folding or tying as appropriate for the treatment or transport
- placement of liquid wastes in capped or tightly stoppered bottles or flasks

- no compaction of infectious waste or packaged infectious waste before treatment

IV. Storage of Infectious Waste

EPA recommends:

- minimizing storage time
- proper packaging that ensures containment of infectious waste and the exclusion of rodents and vermin
- limited access to storage area
- posting of universal biological hazard symbol on storage area door, waste containers, freezers, or refrigerators

V. Transport of Infectious Waste

EPA recommends:

- avoidance of mechanical loading devices which may rupture packaged wastes
- frequent disinfection of carts used to transfer wastes within the facility
- placement of all infectious waste into rigid or semi-rigid containers before transport off-site
- transport of infectious waste in closed leak-proof trucks or dumpsters

VI. Treatment of Infectious Waste

For the purposes of this document, EPA defines treatment as any method, technique or process designed to change the biological character or composition of waste.

EPA recommends:

- establishing standard operating procedures for each process used for treating infectious waste
- monitoring of all treatment processes to assure efficient and effective treatment
- use of biological indicators to monitor treatment (other indicators may be used provided that their effectiveness has been successfully demonstrated)
- the following treatment techniques for each of the six infectious waste categories (table 1):

TABLE 1

RECOMMENDED TECHNIQUES FOR TREATMENT OF INFECTIOUS WASTE[a]

Type of Infectious Waste[b]	Recommended Treatment Techniques				
	Steam Sterilization	Incineration	Thermal Inactivation	Chemical Disinfection[c]	Other
Isolation wastes	X	X			
Cultures and stocks of infectious agents and associated biologicals	X	X	X	X	
Human blood and blood products	X	X		X	X[d]
Pathological wastes	X[e]	X			X[f]
Contaminated sharps	X	X			
Contaminated animal carcasses, body parts, bedding:					
• carcasses and parts	X[e]	X			
• bedding		X			

a. The recommended treatment techniques are those that are most appropriate and, generally, in common use; alternative treatment technique may be used to treat infectious waste, if it provides effective treatment.
b. See Chapter 2 for descriptions of infectious waste types.
c. Chemical disinfection is most appropriate for liquids.
d. Discharge to sanitary sewer for treatment in municipal sewerage system (provided that secondary treatment is available)
e. For aesthetic reasons, steam sterilization should be followed by incineration of the treated waste or by grinding with subsequent flushing to the sewer system in accordance with State and local regulations.
f. Handling by a mortician (burial or cremation).

Treatment of Infectious Waste (cont'd)

EPA recommends:

° the following treatment methods for miscellaneous contaminated wastes (when a decision is made to manage these wastes as infectious):

- wastes from surgery and autopsy - incineration or steam sterilization
- miscellaneous laboratory wastes - incineration or steam sterilization
- dialysis unit wastes - incineration or steam sterilization
- contaminated equipment - incineration, steam sterilization, or gas/vapor sterilization

VII. Disposal of Treated Infectious Waste

EPA recommends:

° contacting State and local governments to identify approved disposal options (institutional programs must conform to State and local requirements)

° discharge of treated liquids and ground up solids (such as pathological waste or small animals) to the sewer system

° land disposal of treated solids and incinerator ash

° rendering body parts unrecognizable before land disposal (for aesthetic reasons)

CHAPTER 1

INTRODUCTION

1.1 Purpose and Scope

This document outlines the EPA perspective on environmentally acceptable techniques for infectious waste management. Topics covered include a definition of infectious waste, types of infectious waste, and recommended practices for packaging, transportation, treatment, storage, and disposal of these wastes.

This document is intended to provide guidance to persons responsible for infectious waste management decisions at the following types of facilities:

- hospitals
- medical laboratories
- research laboratories
- commercial diagnostic laboratories
- animal experimentation units
- industrial plants and laboratories
- other facilities which generate infectious waste

This document will be useful to biological safety officers, environmental and facility engineers, hospital infection control officers and committees, laboratory supervisors, environmental services, housekeeping and custodial staff, administrators, and others involved with infectious waste management. State and local regulatory agencies may also find this manual useful as resource material. The EPA strongly urges, however, that such agencies use this document only as reference material.

Described in detail are infectious waste treatment methods including steam sterilization, incineration, thermal inactivation, gas/vapor sterilization, and chemical disinfection. Included in the discussion of each treatment method are recommendations for monitoring and a description of factors that may affect treatment. The document also contains an up-dated list of State infectious waste regulations and requirements, as well as a list of State offices that may be contacted for further information.

The following elements of an overall program for managing infectious waste are described in this guidance document:

- Designation of infectious waste
- Handling infectious waste
  - Storage (when necessary)
  - Packaging
  - Transport (on- and off-site)
- Selection of appropriate treatment and disposal methods
- Monitoring of treatment methods
- Compliance with State and local requirements

Due to factors such as variability of facility size, availability of treatment alternatives, budgetary constraints, and location, the elements of an effective program may differ among facilities. Nevertheless, this document is designed to provide assistance to persons seeking to meet the challenge of developing an environmentally sound infectious waste management system.

Although the additional hazards (such as toxicity, ignitability, reactivity, etc) that may be associated with some infectious waste are not addressed in this document, waste management decisions

should take into account all hazards posed by the waste. Persons responsible for waste management decisions should set management priorities which take into account the characteristics of the waste which cause it to be regulated by the State or EPA. For example, the EPA hazardous waste regulations address the management of toxic, ignitable, corrosive, and reactive wastes (1,2). The Nuclear Regulatory Commission regulations address the management of radioactive wastes (3).

1.2 State Regulations Pertaining to Infectious Waste

Historically, control of infectious waste has been the responsibility of State health or environmental departments. Most States have requirements for licensing of hospitals and nursing homes that may include general requirements for infectious waste disposal. These general requirements are limited in scope and do not usually apply to other sources of infectious waste.

Since the passage of the Resource Conservation and Recovery Act of 1976, many States have passed hazardous waste legislation to control the treatment, storage, and disposal of infectious waste (as part of their hazardous waste program). Some States have already promulgated regulations controlling infectious waste, while some others are now preparing such regulations. Since there is no unanimity of opinion on the hazards posed by infectious waste and appropriate techniques for safe disposal of these waste, State control varies.

The EPA has conducted a survey of the 50 States and the District of Columbia to determine their infectious waste management requirements. The data are presented in the Appendix to this

document. The Appendix lists the State agency responsible for infectious waste, the statutory authorities, and infectious waste management requirements.

CHAPTER 2

INFECTIOUS WASTE CHARACTERIZATION

2.1 Definition of Infectious Waste

The definition of infectious waste has been debated for years. Regulatory agencies, hospitals, and research laboratories have different perspectives and objectives which influence their views; therefore, there is no universally accepted definition for infectious waste. Moreover, there is inconsistency in the terminology used to define these wastes. For example, the terms infectious, pathological, biomedical, biohazardous, toxic, and medically hazardous have all been used to describe infectious waste.

For purposes of this guidance document, infectious waste is defined as waste capable of producing an infectious disease. This definition requires a consideration of certain factors necessary for induction of disease. These factors include:

a) presence of a pathogen of sufficient virulence

b) dose

c) portal of entry

d) resistance of host

Therefore, for a waste to be infectious, it must contain pathogens with sufficient virulence and quantity so that exposure to the waste by a susceptible host could result in an infectious disease. The six categories listed below are recommended EPA infectious waste categories:

- isolation wastes
- cultures and stocks of infectious agents and associated biologicals
- human blood and blood products
- pathological wastes
- contaminated sharps
- contaminated animal carcasses, body parts, and bedding

There are additional materials which should be evaluated to determine whether they may pose a health hazard because of potential infectiousness. These include, but are not limited to, contaminated equipment, wastes from surgery and autopsy, miscellaneous laboratory wastes, and dialysis unit wastes. EPA has not designated these wastes as infectious waste because of a lack of information on the relative risk of infection or disease. Therefore, it is recommended that a responsible authorized person or committee at the individual facility evaluate these wastes to determine which should be managed as infectious waste.

2.2 Types of Infectious Waste

2.2.1 Isolation Wastes

Isolation wastes are wastes generated by hospitalized patients who are isolated to protect others from communicable diseases (4). At a minimum, wastes from patients with diseases considered communicable and requiring isolation, as defined by the Centers for Disease Control (CDC), should be considered infectious wastes (see Guidelines for Isolation Precautions in Hospitals, July 1983). It should be noted that the wastes from hospital patients who are placed in protective isolation (i.e., isolation imposed only to protect these patients from the diseases of others) are not necessarily infectious. EPA recommends that isolation wastes be managed in accordance with the CDC guidelines (5).

2.2.2 Cultures and Stocks of Infectious Agents and Associated Biologicals

All cultures and stocks of infectious agents should be designated as infectious wastes because of the high concentrations of pathogenic organisms typically present in these materials. Included in this category are specimen cultures from medical and pathological laboratories, cultures and stocks of infectious agents from research and industrial laboratories, wastes from the production of biologicals, and discarded live and attenuated vaccines. Also, culture dishes and devices used to transfer, inoculate, and mix cultures should be designated as infectious waste.

2.2.3 Human Blood and Blood Products

All waste human blood and blood products (such as serum, plasma, and other blood components) should be managed as infectious waste.

2.2.4 Pathological Wastes

Pathological wastes consist of tissues, organs, body parts, and body fluids that are removed during surgery and autopsy. All pathological wastes should be considered infectious because of the possibility of unknown infection in the patient or corpse.

2.2.5 Contaminated Sharps

All discarded sharps (e.g., hypodermic needles, syringes, pasteur pipettes, broken glass, scalpel blades) which have come into contact with infectious agents during use in patient care or in medical, research, or industrial laboratories present the double hazard of inflicting injury and inducing disease. These wastes should be managed as infectious wastes. All sharps used in patient care should be considered infectious wastes because of the possibility of undiagnosed blood-borne diseases (e.g., hepatitis B and AIDS).

2.2.6 Contaminated Animal Carcasses, Body Parts, and Bedding

This infectious waste category includes the contaminated carcasses, body parts, and bedding of animals that were intentionally exposed to pathogens in research, in the production of biologicals, or in the in vivo testing of pharmaceuticals.

2.3 Miscellaneous Contaminated Wastes - (Optional Category)

The following wastes are not designated as infectious waste by the EPA. But, in light of the potential hazards posed by these wastes, a determination to manage these wastes as "infectious" should be made by a responsible authorized person at the facility. The Agency recommends, however, that wastes from patients known to be infected with blood-borne disease be managed as infectious waste.

- Wastes from surgery and autopsy - all contaminated wastes from septic ("dirty") cases; some or all wastes from "clean" cases that were in contact with patient tissues, blood, body fluids, secretions, and excretions. Examples of these wastes include soiled dressings, sponges, drapes, lavage tubes, drainage sets, underpads, and surgical gloves.
- Contaminated laboratory wastes - wastes from medical, pathological, pharmaceutical, or other research, commercial, or industrial laboratories that were in contact with infectious agents. Examples of these wastes include specimen containers, slides and cover slips, disposable gloves, lab coats, and aprons.

- Dialysis unit wastes - wastes that were in contact with the blood of patients undergoing hemodialysis. These wastes include contaminated disposable equipment and supplies such as tubing, filters, disposable sheets, towels, gloves, aprons, and lab coats.
- Contaminanted equipment - discarded equipment and parts that may be contaminated with infectious agents. These wastes include equipment used in patient care, medical and industrial laboratories, research, and in the production and testing of certain pharmaceuticals.

CHAPTER 3

INFECTIOUS WASTE MANAGEMENT

3.1 Introduction

The objectives of an effective infectious waste management program should be to provide protection to human health and the environment from hazards posed by the waste. Proper management ensures that infectious waste is handled in accordance with established procedures from the time of generation through treatment of the waste (to render it non-infectious) and its ultimate disposal.

An infectious waste management system should include the following elements:

- ° Designation of infectious wastes
- ° Handling of infectious wastes which includes:
  - Segregation
  - Packaging
  - Storage
  - Transport and handling
  - Treatment techniques
  - Disposal of treated waste
- ° Contingency planning
- ° Staff training

Various options are available for the development of an infectious waste management system. Management options and the relevant factors that should be considered in their selection are discussed in Section 3.2. Management options for an individual facility

should be selected on the basis of what is most appropriate for that particular facility. Factors such as location, size, and budget should be taken into consideration. The selected options should be incorporated into a documented infectious waste management plan (see Section 3.3). An infectious waste management system cannot be effective unless it is fully implemented. Therefore, a specific person at the generating facility should be responsible for implementation of the plan. This person should have the responsibility as well as the authority to make sure that the provisions of the management plan are being followed.

3.2 Selection of Waste Management Options

In an infectious waste management system, there are a number of areas in which alternative options are available (e.g., treatment techniques for the various types of infectious waste, types of treatment equipment, treatment sites, various waste handling practices, etc.). The selection of available options at a facility depends upon a number of factors such as the nature of the infectious waste, the quantity of infectious waste generated, the availability of equipment for treatment on-site and off-site, regulatory constraints, and cost considerations. These factors are presented here in order to provide assistance in the development of an infectious waste management program.

Since treatment methods vary with waste type, the waste must be evaluated and categorized with regard to its potential to cause disease. Such characteristics as chemical content, density, water content, bulk, etc. are known to influence waste treatment decisions. For example, many facilities use a

combination of treatment techniques for the different components of the infectious waste stream -- e.g., steam sterilization for laboratory cultures and incineration for pathological waste.

The quantity of each category of infectious waste generated at the facility may also influence the method of treatment. Decisions should be made on the basis of the major components of the infectious waste stream. Generally, it would be desirable and efficient to handle all infectious waste in the same manner. However, if a selected option is not suitable for treatment of all wastes, then other options must be included in the infectious waste management plan.

Regulation at the Federal, State, and local level may have impact on the treatment of infectious waste. For example, although there are no Federal air pollution regulations that apply specifically to infectious waste incineration, some States regulate hospital incinerators (6). Furthermore, many localities apply particulate standards to all incinerators regardless of type. Water quality regulations may also be applicable. For example, regulations and standards pertaining to chemical pollutants, thermal discharges, organic loading (biological oxygen demand), and particulates (total suspended solids) are relevant to the infectious waste treatment systems that utilize chemicals, thermal inactivation, and grinding, respectively, as part of the treatment process.

In addition, States have regulations that specify requirements for the disposal of pathological waste and sharps. Therefore, it is imperative that State, and local regulations be carefully considered when developing an infectious waste treatment plan.

Another important factor in the selection of options for infectious waste management is the availability of on-site and off-site treatment. On-site treatment of infectious waste provides the advantage of a single facility or generator maintaining control of the waste. For some facilities, however, off-site treatment may offer the most cost effective option. Off-site treatment alternatives include such options as morticians (for pathological wastes), a shared treatment unit at another institution, and commercial or community treatment facilities. With off-site treatment, precautions should be taken in packaging and transporting to ensure containment of the infectious waste. In addition, generators should comply with all State and local regulations pertaining to the transport of infectious waste, and ensure that the waste is being handled and treated properly at the off-site treatment facility.

It is also important to consider prevailing community attitudes in such matters as site selection for off-site treatment facilities. These include local laws, ordinances, and zoning restrictions as well as unofficial public attitudes which may result in changes in local laws.

Cost considerations are also important in the selection of infectious waste management options. Cost factors include

personnel, equipment cost (capital expense, annual operating, and maintenance), hauling costs (for infectious waste and the residue from treatment), and, if applicable, service fees for the off-site treatment option.

3.3 Infectious Waste Management Plan

EPA recommends that each facility establish an infectious waste management plan. A responsible person at the facility should prepare a comprehensive document that outlines policies and procedures for the management of infectious waste (including infectious wastes with multiple hazards). This recommendation is consistent with the standard of the Joint Commission on Accreditation of Hospitals (JCAH) which specifies a system "to safely manage hazardous materials and wastes" (7).

In addition to the overall infectious waste management plan, it is appropriate to specify detailed instructions for research and clinical laboratories within the facility where infectious waste is generated.

3.3.1 Designation of Infectious Waste

The first element of an infectious waste management plan is to specify which wastes are to be managed as infectious waste. EPA has designated six categories of wastes as infectious; however, as stated earlier, other potentially contaminated wastes should be evaluated on an individual basis by an authorized responsible person or committee.

3.3.2 Segregation of Infectious Waste

Infectious waste should be separated from the general waste stream to assure that these wastes will receive appropriate

handling and treatment. Also, segregation of the waste assures that the added costs of special handling will not be applied to non-infectious waste (8). Infectious waste should be segregated from the general waste stream at the point of generation (i.e., the point at which the material becomes a waste). It is best accomplished by those who generate the waste and, therefore, are best qualified to assess the hazards associated with the waste.

Provisions should be made for infectious waste with multiple hazards. These wastes should be segregated from the general infectious waste stream when additional or alternative treatment is required, or in cases where the wastes are regulated under Federal or State rules.

Infectious waste should be discarded directly into containers or plastic bags which are clearly identifiable and distinguishable from the general waste stream. Containers should be marked with the universal biological hazard symbol (Figure 3-1) (9, 10, 11, 12, 13). Plastic bags also should be distinctively colored or marked with the universal biological hazard symbol. Red or orange colored plastic bags generally are used to identify infectious waste.

FIGURE 3-1

THE BIOLOGICAL HAZARD SYMBOL

The symbol is fluorescent orange or orange-red. The background may be any color that provides sufficient contrast for the symbol to be clearly defined. For specifications of dimensions, see p. 114 of reference 9.

3.3.3. Packaging of Infectious Waste

Infectious waste should be packaged in order to protect waste handlers and the public from possible injury and disease that may result from exposure to the waste. Infectious waste should be contained from the point of origin up to the point at which it is no longer infectious. Therefore, the integrity of the packaging must be preserved through handling, storage, transportation, and treatment.

The following factors should be considered in selecting appropriate packaging:

- waste type
- handling and transport of the packaged waste (before treatment)
- treatment technique
- special considerations for plastic bags
- package identification

Waste Type. To provide adequate waste containment, packaging should be appropriate for the type of waste. For example, liquid infectious waste should be placed in capped or tightly stoppered bottles or flasks. Containment tanks may be used for large quantities of liquid waste. Solid or semi-solid wastes such as pathological wastes, animal carcasses, and laboratory wastes may be placed in plastic bags.

Sharps should be placed directly into impervious, rigid, and puncture-resistant containers to eliminate the hazard of physical injury. Clipping of needles is not recommended.

Suitable containers for sharps are glass, metal, rigid plastic, wood, and heavy cardboard; containers should be compatible with selected treatment processes. Sharps containers should be marked with the universal biohazard symbol and sealed before handling.

Handling and Transport of Packaged Waste Before Treatment. If the waste is to be moved within the facility for treatment or storage, single plastic bags may not effectively contain the waste. If necessary, additional packaging should be used to preserve the integrity of the bags and to ensure containment of the waste. One option is to place single-bagged waste within a rigid or semi-rigid container such as a bucket, box, or carton. Plastic bags may be used as liners for such containers. Another suitable practice is double-bagging, that is, placing the sealed plastic bag within another bag which is subsequently sealed. Containers of sharps and liquids may be placed within other containers (e.g., boxes) for ease of handling. The containers should be covered with secure lids during transport and storage. Lids may be opened during the treatment process.

Whenever plastic bags of infectious waste are handled and especially when they are transferred, care must be exercised to prevent tearing of the bags. For example, plastic bags containing infectious waste should not be transported through a chute or dumb-waiter. In general mechanical devices should not be used for transport or loading of plastic bags containing these wastes. Good practices for handling plastic bags include

loading by hand, transporting the loaded dumpster to minimize handling, and placing the plastic bags within rigid or semi-rigid containers before handling and transport.

When infectious waste is transported off-site for treatment, plastic bags -- single or double -- should be placed within rigid or semi-rigid containers to maintain the integrity of the packaging and prevent spillage. Depending on the management system, these containers can be recycled or disposed of. Recycled containers (such as heavy plastic barrels) which are used repeatedly for transport and treatment of bagged waste should be disinfected after each use. Single-use containers (such as strong cartons) are usually destroyed as part of the treatment process (e.g., incineration).

Infectious waste should not be compacted prior to treatment because compacting may actually disperse the infectious waste by destroying the integrity of the packaging. In addition, compaction may interfere with the effectiveness of the treatment process.

Treatment Techniques. Incineration requires that containers be combustible. Effective steam sterilization, however, requires that packaging materials allow steam penetration and evacuation of air. Therefore, a single packaging technique may not be suitable for all treatment processes. For example, autoclavable bags which typically are constructed of high-density plastics may prevent effective treatment by trapping air within the bags and impeding steam penetration. This prevents the waste from attaining temperatures necessary for adequate treatment (14, 15). Interference with the treatment process may also result

from the type of plastic. Substitution with low density plastics will enhance steam penetration and facilitate air evacuation from the load. However when low density plastic bags are used they should be placed within heat-resistant containers to assure containment of the waste during the steam sterilization process.

Special Considerations for Plastic Bags. Several types of plastic bags are available. The quality of a plastic bag and its suitability for use to contain infectious waste are determined by the raw materials used in its manufacture and the product specifications. Two different criteria are often used to judge the suitability of a plastic bag: its thickness and its durability, as evaluated by the ASTM dart test (16). These standards have been incorporated separately into some State regulations. For example, Massachusetts regulations specify bag thickness; California regulations, however, require the dart test. Therefore, procurement should be based on one or both of these standards. The important consideration is the selection of tear-resistant plastic bags that maintain their integrity (at least until the waste is treated) and, thus, prevent dispersal of infectious agents into the environment. The incidence of bag tearing can be r duced somewhat, but not eliminated completely, by measures such as using tear-resistant plastic bags for infectious waste; not placing sharps, sharp items, or items with sharp corners in the bags; not overloading a bag beyond its weight and volume capacity; and exercising special care during handling in order

to keep the plastic bags from coming into contact with external sharp objects. Another helpful technique is the use of double-bagging rather than a single plastic bag.

For aesthetic reasons, opaque plastic is preferable when plastic bags are used to contain certain types of infectious waste (for example, pathological wastes) -- with opaque plastic, the contents of the bag are not visible. Translucent bags are suitable for infectious waste when aesthetics is not a concern.

Package Identification. Packaged infectious waste should be easily identifiable. This may be accomplished by the use of containers with the distinctive red or orange color that indicates biohazardous material. Another option is the use of the universal biohazard symbol (Figure 3-1) on all infectious waste packages and containers. The identification system should include clear labelling to indicate all hazards that are present in the waste.

3.3.4 Storage of Infectious Waste

While it is preferrable to treat infectious waste as soon as possible after generation, same day treatment is not always possible or practical. For example, treatment equipment may not be available because of insufficient capacity, malfunction, or unavailability of personnel. In such cases it may be necessary to store the waste.

There are four important factors to be considered when storing infectious waste -- the integrity of the packaging, storage temperature, the duration of storage, and location and design of the storage area.

The packaging should provide containment of the waste through-

out the waste management process. In addition, the packaging should deter rodents and vermin which can be vectors in disease transmission.

Storage temperature and duration are important considerations. As temperature increases, the rates of microbial growth and putrefaction also increase. This results in the unpleasant odors typically associated with wastes containing decaying organic matter.

There is no unanimity of opinion on optimum storage time and temperature. Some States, however, establish storage requirements as a function of time and temperature. For example, regulations in California permit storage for a maximum of four days at temperatures above 32°F. Massachusetts allows infectious waste to be stored for one day at room temperature (64°-77°F) or for three days in a refrigerator (34°-45°F). These requirements are for total storage time prior to treatment, regardless of whether the waste is stored at the generating facility or at a separate treatment facility. EPA recommends that storage times be kept as short as possible.

The storage area should be a specially designated area located at or near the treatment site. For security reasons, the storage area should have limited access that restricts the entry of unauthorized personnel. It should be kept free of rodents and vermin. In addition, the universal biohazard label should be posted where appropriate (e.g., doors, waste containers, refrigerators, and freezers).

3.3.5 Transport of Infectious Waste (on- and off-site)

There are two factors which should be considered to ensure safe transport of infectious waste both within the facility and to an off-site treatment facility. Proper packaging is necessary to ensure containment of the waste. Mechanical devices should not be used to transfer or load infectious waste since rupturing of the packaging and dissemination of the waste may result.

Carts are suitable for moving packaged infectious waste within the facility. These carts should be disinfected frequently. Carts used to transport infectious waste should not be used for other materials prior to decontamination.

The use of appropriate hazard symbols should be in accordance with municipal, State and Federal regulations. The waste should be transported in closed and leak-proof dumpsters or trucks to prevent scattering, spillage, and leakage of the waste during off-site transport. EPA does not consider the truck as a rigid containment system; rather it serves only as a transport mechanism. Therefore, all infectious waste should be placed in rigid or semi-rigid, leak-proof containers before being loaded on the truck.

3.3.6 Treatment of Infectious Waste

Since package integrity cannot be ensured during landfilling, loss of containment may result in dispersal of infectious waste into the environment. Therefore, to ensure protection from the potential hazards posed by these wastes, EPA recommends that all infectious waste be treated prior to disposal.

"Treatment" for purposes of this document means any method, technique, or process designed to change the biological character or composition of waste.

The purpose of treating infectious waste is to reduce the hazard associated with the presence of infectious agents. To be effective, treatment must reduce or eliminate pathogens (present in the waste) so that it no longer poses a hazard to persons who may be exposed to it. Waste that is effectively treated may be handled and disposed of as general refuse.

The information presented in Chapter 4 of this document summarizes methods commonly used to treat infectious waste. Chapter 5 provides suggested treatment techniques for each type of infectious waste.

3.3.7 Disposal of Treated Waste

Infectious waste which has been effectively treated is no longer biologically hazardous and may be mixed with and disposed of as ordinary waste, provided the waste does not pose other hazards that are subject to Federal or State regulations.

Treated liquid wastes may be poured down the drain to the sewer system. Sewer disposal is also an option for certain treated solid wastes (e.g., pathological waste) that are amenable to grinding and flushing to the sewer system. Sewer disposal, however, is subject to the approval of the local sewer authority. Treated solid wastes and incinerator ash can be disposed of in a sanitary landfill.

Additional processing of some wastes may be necessary or advisable before disposal. For example, some States require that

needles and syringes be rendered non-useable before disposal. Treated sharps can be ground up, incinerated, or compacted. For aesthetic reasons body parts should not be recognizable when disposed of.

3.3.8 Contingency Planning

The infectious waste management plan should include a contingency plan to provide for emergency situations. It is important that these measures be selected in a timely manner so that they can be implemented quickly when needed.

This plan should include, but not be limited to, procedures to be used under the following circumstances:

- spills of liquid infectious waste -- clean-up procedures, protection of personnel, and disposal of spill residue,
- rupture of plastic bags (or other loss of containment) -- clean-up procedures, protection of personnel, and repackaging of waste,
- equipment failure -- alternative arrangements for waste storage and treatment (e.g., off-site treatment).

3.3.9 Staff Training

Facilities that generate infectious waste should provide employees with infectious waste management training. This training should include an explanation of the infectious waste management plan and assignment of roles and responsibilities for implementation of the plan. Such education is important for all employees who generate or handle infectious wastes regardless of the employee's role (i.e., supervisor or supervised) or type of work (i.e., technical/scientific or housekeeping/maintenance).

Training programs should be implemented:

- when the infectious waste management plans are first developed and instituted,
- when new employees are hired, and
- whenever infectious waste management practices are changed.

Continuing education is also an important part of staff training. Refresher training aids in maintaining personnel awareness of the potential hazards posed by infectious wastes. Training also serves to reinforce waste management policies and procedures that are detailed in the infectious waste management plan.

CHAPTER 4

TREATMENT OF INFECTIOUS WASTE

4.1 Introduction

The purpose of treating infectious waste is to change its biological character so as to reduce or eliminate its potential for causing disease. Incineration and steam sterilization are the most frequently used infectious waste treatment techniques. However, other processes are effective in treating infectious waste.

Facilities involved with the treatment of infectious waste should establish standard operating procedures for each treatment process. Standardization of procedures should include establishing acceptable operating limits which take into account all factors that may effect the treatment process.

The following treatment techniques are discussed in this chapter:

- Steam sterilization (autoclaving)
- Incineration
- Thermal inactivation
- Gas/vapor sterilization
- Chemical disinfection
- Sterilization by irradiation

4.1.1 Monitoring

A convenient approach for determining treatment effectiveness is the use of biological indicators (17). Biological indicators are standardized products that are routinely used to demonstrate

the effectiveness of the treatment process (18). It is now current practice to use spores of a resistant strain of a particular bacterial species for testing each specific treatment process. The United States Pharmacopeia recommends the use of biological indicators for monitoring treatment processes such as steam sterilization, incineration, and thermal inactivation (19, 20).

There are other indicators that provide an instantaneous indication -- usually by a chemically induced color change -- of the achievement of a certain temperature. However, these indicators are not suitable for use in monitoring the sterilization process because each treatment technique involves a combination of factors; therefore, no single factor is a valid criterion for indicating the effectiveness of the sterilization process. (For example, in steam treatment, the wastes must be exposed to a certain temperature for at least a minimum period of time in order to achieve sterilization. Therefore, any indicator that indicates only the attainment of a particular temperature is not suitable for monitoring the effectiveness of steam sterilization).

Other indicators which monitor the treatment process may be used (21, 22). However, it is recommended that the appropriateness and reliability of these indicators be confirmed before they are used to monitor infectious waste treatment.

It is essential that indicators be properly placed within the waste load so that they will indicate accurately the effect of treatment on the entire waste load. Therefore, to assure accurate monitoring, the biological indicators should be distributed throughout the waste load.

Monitoring is essential in development of standard operating procedures for each treatment technique to verify that the treatment process is effective. Monitoring also permits refinement of the operating procedures so that excess processing can be avoided while savings are realized in expenditures of time, energy, and/or materials. Subsequent periodic monitoring serves to demonstrate sterilization, thereby confirming that proper procedures were used and that the equipment was functioning properly.

4.2 Steam Sterilization

Steam sterilization of infectious waste utilizes saturated steam within a pressure vessel (known as steam sterilizer, autoclave, or retort) at temperatures sufficient to kill infectious agents present in the waste (17).

There are two general types of steam sterilizers -- the gravity displacement type, in which the displaced air flows out the drain through a steam-activated exhaust valve, and the pre-vacuum type, in which a vacuum is pulled to remove the air before steam is introduced into the chamber. With both types, as the air is replaced with pressurized steam, the temperature of the treatment chamber increases. This results in temperature increases within the waste load which under most conditions are sufficient to treat the waste.

Treatment by steam sterilization is time and temperature dependent; therefore, it is essential that the entire waste load is exposed to the necessary temperature for a defined

period of time. (Heating of the containers and the waste usually lag behind heating of the chamber (17, 23).)

In steam sterilization, decontamination of the waste occurs primarily from steam penetration. Heat conduction provides a secondary source of heat transfer. Therefore, for effective and efficient treatment, the degree of steam penetration is the critical factor. For steam to penetrate throughout the waste load, the air must be completely displaced from the treatment chamber. The presence of residual air within the sterilizer chamber can prevent effective sterilization by: reducing the ultimate possible temperature of the steam, regardless of pressure; causing variations in temperature throughout the chamber; prolonging the time needed to attain the maximum temperature; and inhibiting steam penetration into porous materials (17). Factors that can cause incomplete displacement of air include: use of heat resistant plastic bags (which may exclude steam or trap air), use of deep containers (which may prevent displacement of air from the bottom), and improper loading (which may prevent free circulation of steam within the chamber).

The principal factors that should be considered when treating infectious waste by steam sterilization are:

- type of waste
- packaging and containers
- volume of the waste load and its configuration in the treatment chamber.

Types of Waste. Infectious waste with low density (such as plastics) is more amenable to steam sterilization. High density wastes such as large body parts, and large quantities of animal bedding and fluids inhibit direct steam penetration and require longer sterilization time. Alternative treatment methods should be considered (e.g., incineration) for these wastes.

Packaging and Containers. A variety of containers are used in steam sterilization including plastic bags, metal pans, bottles, and flasks. One consideration with plastic bags is the type and thickness of the plastic and its suitability for use in steam treatment. As discussed earlier, some plastic bags are marketed as autoclavable (i.e., they are heat resistant and do not melt). These bags are constructed of high density polyethylene or polypropylene plastic and, therefore, do not facilitate steam penetration to the waste load (14, 15). Bags made of heat-labile plastic have been found to crumble and melt during steam treatment which allows steam penetration of the waste but destroys the bag as a container. When heat-labile plastic bags are used, they should be placed within another heat stable container which allows steam penetration (e.g., strong paper bag). It is good policy to place plastic bags within a rigid container before steam treatment in order to prevent spillage and drain clogging. To facilitate steam penetration, bags should be opened and bottle caps and stoppers should be loosened immediately before placement in the steam sterilizer.

Volume and Configuration of the Waste Load. The volume of the waste is an important factor in steam sterilization as it can

be difficult to attain sterilizing temperatures in large loads. It may be more efficient to autoclave a large quantity of waste in two small loads rather than one large load (24).

Many infectious wastes that have multiple hazards should not be steam sterilized because of the potential for exposure of equipment operators to toxic, radioactive, or other hazardous chemicals. Infectious wastes that should not be steam sterilized include those that contain antineoplastic drugs, toxic chemicals, or chemicals that would be volatilized by steam.

Persons involved in steam sterilizing infectious waste should be educated in proper techniques to minimize personal exposure to the hazards posed by these wastes. These techniques include use of protective equipment, minimization of aerosol formation, and prevention of spillage of waste during autoclave loading.

A recording thermometer should be used to ensure that a sufficiently high temperature is maintained for an adequate period of time during the cycle. Failure to attain or maintain operating temperature may indicate mechanical failure.

All steam sterilizers should be routinely inspected and serviced. Monitoring the steam sterilization process is required to ensure effective treatment. The process should be monitored periodically to check that proper procedures are being followed and that the equipment is functioning properly. Bacillus

- waste feed rate
- combustion temperature

Variations in Waste Composition. Waste composition affects combustion conditions due to variations in moisture content and heating value. It is important to adjust loading rate and combustion temperature, as needed, to maintain proper incinerating conditions.

Waste Feed Rate. The rate at which waste is fed into the incinerator also affects the efficacy and efficiency of treatment. It is important to avoid overloading which often results in incomplete combustion and unsatisfactory treatment of infectious waste.

Combustion Temperature. An optimum temperature must be maintained during combustion to ensure proper treatment of infectious waste. The combustion temperature can be maintained, as necessary, by adjustments in the amount of combustion air and fuel.

With pathological incinerators, in particular, it is essential that operating temperatures be attained before loading the waste. The amount of air and fuel should be adjusted to maintain the combustion temperature at the necessary level. Adjustments should be made as the composition of the waste changes.

stearothermophilus is recommended by The United States Pharmacopeia (19, 20) as the biological indicator for monitoring steam sterilization. There are other indicators that may effectively monitor the treatment process; however, because steam sterilization is both time and temperature dependent, any indicator that is used should effectively monitor both these factors.

4.3 Incineration

Incineration is a process which converts combustible materials into noncombustible residue or ash. The product gases are vented to the atmosphere through the incinerator stack while the treatment residue may be disposed of in a sanitary landfill. Incineration provides the advantage of greatly reducing the mass and volume of the waste -- often by more than 95 percent -- which, in turn, substantially reduces transport and disposal costs.

Incineration can be a suitable treatment technique for all types of infectious waste. Incineration is especially advantageous with pathological waste and contaminated sharps because it renders body part unrecognizable and sharps unuseable. Incinerators that are properly designed, maintained, and operated are effective in killing organisms that are present in infectious waste. However, if the incinerator is not operating properly, viable pathogenic organisms can be released to the environment in stack emissions, residue ash, or wastewater (25, 19, 26, 27).

The principal factors that should be considered when incinerating infectious waste are:

° variation in waste composition

For infectious waste with multiple hazards, special considerations are appropriate. For example, infectious waste that contains or is contaminated with antineoplastic drugs should be incinerated only in an incinerator that provides the high temperature and long residence (dwell) time that are necessary for the complete destruction of these compounds.

The plastic content of the waste also should be considered before incineration is selected as a treatment technique. Many incinerators can be damaged by temperature surges caused by combustion of large quantities of plastic (such as contaminated disposables). Another factor to be considered is the chlorine content of polyvinyl chloride and other chlorinated plastics that may be present in the waste. The combustion products of these plastics include hydrochloric acid which is corrosive to the incinerator and may damage the refractory (lining of the chamber) and the stack. Limiting the plastic content of waste loads burned in incinerators will extend the life of these units.

Since infectious waste must be exposed to a sufficiently high temperture for an adequate period of time to ensure destruction of all pathogenic organisms, specific standards should be established to define minimum operating temperatures. For example, the Massachusetts policy for incineration of infectious waste specifies that all new incinerators must operate at a minimum temperature of 1600°F in the secondary combustion chamber and a minimum residence time of one second.

In addition to operating procedures, design features can also affect the incineration process (25). For example,

mechanical controls can help ensure that infectious waste is exposed to the appropriate combustion temperature. Lock-out devices can be installed to prevent ignition of the primary chamber until the secondary chamber is at operating temperature. Shut-down devices will keep the secondary chamber at operating temperature for a certain period of time after the primary chamber is shut off or until it cools t a certain temperature. Monitors which provide continuous information on combustion temperature, waste feed rate, fuel feed rate, and air feed rate are essential for monitoring the process.

Pathological incinerators have traditionally been used by hospitals to incinerate pathological and other infectious waste. These incinerators have relatively small capacity, and generally are operated intermittently. Some larger facilities have considered installation of resource recovery incinerators (i.e., heat recovery from incineration of all wastes -- including infectious wastes). However, these incinerators may be subject to regulation under the Federal Clean Air Act, or the Resource Conservation and Recovery Act (hazardous waste regulations) if certain hazardous waste are burned (28, 29). At present, pathological incinerators are not subject to Federal regulations promulgated under either the Clean Air Act or Resource Conservation and Recovery Act. However, many States and localities have frequently applied emission standards, in particular, standards for particulate emissions and carbon monoxide, to all incinerators (including pathological) within their jurisdictions.

The absence of regulations that apply to hospital incinerators does not relieve a hospital of responsibility for meeting the criteria for proper incineration of infectious waste. Therefore, even though infectious waste incinerators may not be regulated, hospitals and other facilities treating infectious waste by this method should ensure that the waste is being properly incinerated.

4.4 Thermal Inactivation

Thermal inactivation includes treatment methods that utilize heat transfer to provide conditions that reduce the presence of infectious agents in waste. Generally this method is used for treating larger volumes of infectious wastes (such as industrial applications). Different thermal inactivation techniques are used for treatment of liquid and solid infectious wastes.

4.4.1 Thermal Inactivation of Liquid Infectious Waste

Batch-type liquid waste treatment units consist of a vessel of sufficient size to contain the liquid waste generated during a specific operating period (e.g., 24 hours). The system may include a second vessel that provides continuous collection of waste without interruption of activities that generate the waste.

The waste may be pre-heated by heat exhangers, or heat may be applied by a steam jacket that envelopes the vessel. Heating is continued until a pre-determined temperature (usually measured

by a thermocouple) is achieved and maintained for a designated period of time (analogous to steam sterilization). Mixing may be appropriate to maximize homogeneity of the waste and temperature during the loading and heat application steps of the treatment cycle.

The temperature and holding time depends on the nature of the pathogens present in the waste. Since this treatment method is used most often in industrial applications, the identity of the pathogens are usually known. Time and temperature requirements can be selected on the basis of the resistance of either the pathogen present in the waste or of a pathogen that is more resistant than those being treated.

After the treatment cycle is complete, the contents of the vessel/tank are discharged. These discharges, which are normally to the sewer, must comply with the local, State, or Federal requirements. Since these requirements usually include temperature restrictions, a second heat exchanger may be necessary to remove excess heat from the effluent.

The continuous treatment process for treating liquid infectious waste is actually a semi-continuous process. The system can provide on demand thermal inactivation without the need for a large vessel or tank. A typical system consists of a small feed tank, an elaborate steam-based heat exchanger, a control and monitoring system, and associated piping.

Liquid waste is introduced into the small feed tank, pumped across the heat exchanger at a constant fixed rate of flow, and then recirculated through the feed tank and the rest of the system

until the required temperature has been achieved. Because of the relatively shorter contact time, the treatment temperature may be higher than those in a batch-type system. The treated waste may be cooled by a second heat exchanger before discharge to the sanitary sewer of the facility.

4.4.2 Thermal Inactivation of Solid Infectious Waste

Dry heat treatment may be applied to solid infectious waste. In this technique, the waste is heated in an oven which is usually operated by electricity. Dry heat is a less efficient treatment agent than steam and, therefore, higher temperatures or longer treatment cycles are necessary. A typical cycle for dry heat sterilization is treatment at 320° to 338°F for two to four hours.

The extensive time and energy requirements of thermal inactivation preclude common use of this technique for treatment of solid infectious waste.

4.5 Gas/Vapor Sterilization

Gas/vapor sterilization is an option that may be used for treating certain infectious waste. In this method, the sterilizing agent is a gaseous or vaporized chemical. The two most commonly used chemicals are ethylene oxide and formaldehyde. There is substantial evidence that these chemicals are probable human carcinogens (30,31), and caution must be exercised when they are used. Therefore, when the use of gas/vapor sterilization is considered, the relative hazard of the treatment itself

should be weighed against the benefits resulting from the treatment.

Ethylene oxide gas is often used to sterilize thermolabile supplies but, because of its toxicity and because other options are available, ethylene oxide is not recommended for treating infectious waste.

Formaldehyde gas is used to sterilize certain disposable items which may be contaminated (e.g., HEPA filters from biological safety cabinets). Formaldehyde sterilization procedures should be performed only by persons trained in the use of formaldehyde as a gaseous sterilant.

With both ethylene oxide and formaldehyde, there is the potential for additional exposure after treatment has been completed. Ethylene oxide is absorbed by porous materials, and formaldehyde frequently forms a residue. Both of these phenomena result in continued release of the gases from the treated waste for substantial periods of time after treatment.

4.6 Chemical Disinfection

Chemical treatment is most appropriate for liquid wastes, however, it also can be used in treating solid infectious waste.

In order to use chemicals effectively, the following factors should be considered:

- type of microorganism
- degree of contamination
- amount of proteinaceous material present
- type of disinfectant

- concentration and quantity of disinfectant
- contact time
- other relevant factors (e.g., temperature, pH, mixing requirements, biology of microorganism)

The disposal of chemically treated waste should be in accordance with State and local requirements.

4.7 Sterilization by Irradiation

An emerging technology for treating infectious waste involves the use of ionizing radiation. Experience being gained from irradiation of medical supplies, medical components, food, and other consumer products is providing a basis for the development of practical applications for treatment of infectious waste.

The advantages of ionizing radiation sterilization for treatment of infectious waste relative to other available treatment methods include:

- nominal electricity requirements
- no steam requirements
- no residual heat in treated waste
- performance of the system

The principal disadvantages of a radiation sterilization facility are:

- high capital cost
- requirement for highly trained operating and support personnel
- large space requirement
- problem of ultimate disposal of the decayed radiation source

When properly used and monitored, ionizing radiation may provide an effective method of treating infectious waste.

4.8 Other Treatment Methods

Other methods of treating infectious waste should be demonstrated as effective before being used routinely. Efficacy of the method should be demonstrated by the development of an biological testing program. Monitoring should be conducted on a periodic basis using appropriate indicators.

CHAPTER 5

SUGGESTED TREATMENT METHODS FOR EACH INFECTIOUS WASTE CATEGORY

5.1 Introduction

Suggested treatment methods for each infectious waste category presented in Chapter 4 are outlined in this chapter. These recommendations reflect current practices as well as the opinions of the work group cited in the acknowledgement section of this guidance document.

These recommendations are based solely on the efficacy and feasibility of treatment. It should be emphasized that these recommended treatment techniques do not preclude use of alternative effective treatment methods.

In general, the EPA believes that treated liquid infectious waste or ground up solids may be discharged directly to the sanitary sewer. It is recommended, however, that personnel handling these wastes use discretion to avoid possible clogging of drains. In some States, the landfilling of infectious waste is allowed, in others it is prohibited. EPA recommends that only treated infectious waste be landfilled. It must be noted that if treated waste is no longer infectious, it may be handled as ordinary waste provided it poses no hazard otherwise subject to regulation. If landfilling of infectious waste is allowed by the State, EPA recommends that only well controlled sanitary landfills be used. Persons desiring to landfill untreated infectious waste should consult with State officials and the landfill operator prior to shipping these wastes to the facility.

5.2 Isolation Wastes

Patients placed in isolation (other than protective or reverse isolation) generally have diseases of such severity and contagiousness to require special precautions. To protect the general population from pathogens present in wastes from these patients, it is recommended that these wastes be steam sterilized or incinerated. Feces, urine, and other body fluids may be discharged to the sanitary sewer. However, it is recommended that such waste be discarded in the patient care area, if possible.

5.3 Cultures and Stocks of Infectious Agents and Associated Biologicals

Cultures and stocks of infectious agents, culture dishes, and devices used to transfer, inoculate and mix cultures constitute a particular hazard because pathogenic organisms are present at high concentrations. Therefore, these wastes should be treated prior to disposal (32). Steam sterilization is the preferred treatment method because it is the simplest and most effective. Furthermore, because autoclaves are present in most microbiological laboratories, steam sterilization often can be performed in the laboratory. Treatment at the point of generation makes it unnecessary to transport these wastes through the facility to treatment equipment located elsewhere. If the wastes must be transported from the lab for treatment, steam sterilization, incineration, and thermal inactivation are acceptable treatment alternatives.

Chemical decontamination also provides an alternative treatment method for cultures and stocks. However, when large amounts of liquids are treated by this method,the relatively large volume of chemical disinfectant required to achieve effective treatment may pose ultimate disposal problems.

5.4 Human Blood and Blood Products

Because it is impractical to test all blood for the presence of every possible pathogen, it is prudent to manage all blood and blood products as infectious waste. It is logical to extend this practice to the wastes associated with blood specimens and to handle them as though they were contaminated. Two recommended treatment methods are steam sterilization and incineration. In addition, blood and blood products also may be discharged directly to the sanitary sewer for treatment in the municipal sewerage treatment system provided that secondary treatment is available.

5.5 Pathological Wastes

In addition to the biohazard of pathological waste, other circumstances may affect management of these wastes. For aesthetic reasons, recognizable body parts should not be disposed of in a landfill; rather, these wastes should be incinerated. For religious reasons, some patients prefer that body parts (for example, amputated limbs) be transferred to a mortician for burial or cremation.

Alternatively, pathological waste (such as small organs and body parts) may be steam sterilized and ultimately ground and discharged to the sewer.

5.6 Contaminated Sharps

Two factors should be considered in establishing procedures for the handling, treatment, and disposal of contaminated sharps: the hazard of disease transmission and physical injury. Since the latter factor also pertains to sharps that are not contaminated, a single uniform management system for all sharps is recommended. All sharps upon discard should be placed directly into rigid, puncture resistant containers to avoid injury. Clipping of contaminated needles is not recommended since this may result in the production of an infectious aerosol. However, devices used to clip needles within a totally enclosed system are acceptable.

Contaminated sharps should be treated to eliminate the disease potential. Both incineration and steam sterilization provide effective treatment for contaminated sharps. Treatment by steam sterilization should be followed by compaction or by grinding when required by State or local regulations.

5.7 Contaminated Animal Carcasses, Body Parts, and Bedding

The management of contaminated carcasses and body parts of animals that were intentionally exposed to pathogens is similiar to the management of pathological wastes (See Section 5.5). Incineration of these wastes serves both to treat and destroy the carcass.

Steam sterilization in a retort followed by grinding and flushing to the sewer system is another suitable method for treatment and disposal of these wastes; however, long cycles are necessary. Steam sterilization in autoclaves has only limited use in treatment

of animal carcasses because of size constraints and long treatment times necessary to achieve sterilization. Nevertheless, autoclaving can be useful in two applications: to decontaminate the surface of a carcass before it is transported through a facility to an incinerator, and to treat small carcasses and body parts before they are ground up and flushed to the sewer.

Contaminated animal bedding is best treated by incineration. Steam sterilization may not effectively treat these wastes.

5.8 Miscellaneous Contaminated Waste (Optional Category)

The following treatment methods are recommended whenever one or more of these contaminated wastes are designated as infectious waste:

- contaminated wastes from surgery and autopsy should be treated by incineration or steam sterilization
- contaminated laboratory wastes should be treated by incineration or steam sterilization; thermal inactivation may be appropriate
- dialysis unit wastes should be treated by steam sterilization or incineration
- contaminated equipment and equipment parts should be treated by steam sterilization or incineration; in some situations, gas or vapor sterilization *in situ* is the best treatment alternative (*e.g.*, HEPA filters, large items).

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Appendix

STATE REGULATIONS PERTAINING TO
INFECTIOUS WASTE MANAGEMENT (1986)

State	Statutory Authority and Regulation Citation	Summary of Requirements	State Agency
Alabama	1975 Code of Alabama, Section 22-21-20. Alabama State Board of Health Rules and Regulations for Nursing Homes and Hospitals.	All infectious waste generated by nursing homes and hospitals must be incinerated on site.	Bureau of Licensure and Certification State Health Department Room 652 State Office Building Montgomery, Alabama 36130-1701 (205) 261-5105
	No regulations.	Policy is to recommend treatment of infectious waste prior to disposal.	Alabama Department of Environmental Management Land Division 1751 Federal Drive Montgomery, Alabama 36130 (205) 271-7700
Alaska	Laws of Alaska, Title 44, Chapter 46; Title 46, Chapter 3.	All infectious waste generated by medical and veterinary facilities must be incinerated prior to final disposal.	Air and Solid Waste Management Department of Environmental Conservation Pouch O Juneau, Alaska 99811 (907) 465-2666
		The state has statutory authority to regulate infectious waste as a hazardous waste but has not yet promulgated regulations.	

State	Statutory Authority and Regulation Citation	Summary of Requirements	State Agency
Arizona	Arizona Revised Statutes, Title 36, Article 2, General Hospitals. Regulation R9-10-220, Environmental Services, Subsection E.	All infectious waste must be either (1) autoclaved and disposed of in an approved sanitary landfill, or (2) incinerated in an approved incinerator. Variances are given for disposal of untreated waste when there is insufficient treatment capacity.	Bureau of Health Care Institution Licensure Arizona Department of Health Services 1740 West Adams Street Phoenix, Arizona 85007 (602) 255-1115
Arkansas	Act 414 of 1961, as amended by Act 444 of 1965 and Act 454 of 1965. Rules and Regulations for Hospitals and Related Institutions in Arkansas.	All infectious waste generated by hospitals and related institutions must be incinerated or disposed of by other approved methods. Revisions are expected in 1986.	Department of Health Division of Health Facilities Services 4815 W. Markham Street Little Rock, Arkansas 72205-3867 (501) 661-2201
	The Solid Waste Management Act (237) of 1971. Arkansas Hazardous Waste Management Act of 1979 (Act 406 of 1979).	The state has statutory authority to regulate infectious waste as a hazardous waste but has not yet promulgated regulations.	Solid Waste Management Division Department of Pollution Control and Ecology P.O. Box 9583 8001 National Drive Little Rock, Arkansas 72219 (501) 562-7444

APPENDIX (Continued)

State	Statutory Authority and Regulation Citation	Summary of Requirements	State Agency
California	California Health and Safety Code Chapter 6.5, Article 2, Section 25117.5 California Administrative Code, Title 22. Division 4, Chapter 30: Minimum Standards for Management of Hazardous and Extremely Hazardous Waste; Infectious Waste Regulations, effective November 16, 1985.	Infectious waste must be incinerated, sterilized or treated by other approved methods.	California Department of Health Services Hazardous Materials Management Section 714/744 P Street Sacramento, California 95814 (916) 324-1798
Colorado	Colorado Revised Statutes, 1973, as amended; Title 25, Article 15, Parts 1, 2, and 3: Hazardous Waste Management Act.	The state has statutory authority to regulate infectious waste as a hazardous waste but has not yet promulgated regulations.	Waste Management Division Colorado Department of Health 4210 E. 11th Avenue Denver, Colorado 80220 (303) 320-8333 Ext. 4364
	Chapter 4, Regulations Governing General Hospitals.	Pathological waste must be incinerated. Off-site disposal in approved sites is possible.	Division of Health Facilities Regulations Colorado Department of Health 4210 E. 11th Avenue Denver, Colorado 80220 (303) 320-8333 Ext. 6306

APPENDIX (Continued)

State	Statutory Authority and Regulation Citation	Summary of Requirements	State Agency
Connecticut	Connecticut General Statutes of 1979, Public Act 79-605. Code 22A-4483 and 22A-115.	The state has statutory authority to regulate infectious waste as a hazardous waste but has not yet promulgated regulations.	Hazardous Waste Management Department of Environmental Protection State Office Building 165 Capitol Avenue Hartford, Connecticut 06106 (203) 566-4869 or 566-5712
Delaware	Delaware Code, Title 7, Chapter 60: Solid Waste Act. Delaware Solid Waste Disposal Regulations, August 1974.	Infectious waste disposal is approved on a case-by-case basis. None has been allowed to go to landfills untreated since the approval process was initiated. Revised regulations have been proposed.	Waste Management Section Department of Natural Resources and Environmental Control 89 King Highway P.O. Box 1401 Dover, Delaware 19903 (302) 736-4781

APPENDIX (Continued)

State	Statutory Authority and Regulation Citation	Summary of Requirements	State Agency
District of Columbia	District of Columbia Hazardous Waste Management Act of 1977, D.C. Law 2-64.	The District has statutory authority to regulate infectious waste as a hazardous waste but has not yet promulgated regulations	Department of Consumer and Regulatory Affairs and Environmental Control Division 5010 Overlook Avenue, SW Washington, DC 20032 (202) 767-8414
Florida	Florida Resource Recovery and Management Act (Florida Statutes Annotated, Title 27, Public Health, Chapter 403, Part IV, Enacted by the Laws of 1974, Chapter 342, as amended). Florida Resource Recovery and Management Regulations: Rules of the Department of Environmental Regulation, Chapter 17-7.04.	Infectious waste must be incinerated or treated by an approved treatment method before being placed in a landfill.	Solid Waste Management Program Department of Environmental Regulation Twin Towers Office Building, 6th Floor 2600 Blair Stone Road Tallahassee, Florida 32301 (904) 488-0300 and Department of Health and Rehabilitative Services 1317 Winewood Blvd. Tallahassee, Florida 32301 (904) 488-2905

State	Statutory Authority and Regulation Citation	Summary of Requirements	State Agency
Georgia	Code of Georgia, Annotated, Title 43, Chapter 43-16: Solid Waste Management Act of 1972, as amended. Georgia Department of Natural Resources Rules and Regulations for Solid Waste Management, Chapter 391-3-4, 1972, as amended through 1974.	Infectious waste is considered a special waste. Policy is to require incineration or autoclaving before land disposal.	Land Protection Branch Environmental Protection Division Department of Natural Resources Room 724 270 Washington Street, S.W. Atlanta, Georgia 30334 (404) 656-2833
Hawaii	Hawaii Environmental Laws and Regulations, Vol. I, Title 19, Chapter 342, Part V, as amended by Chapter 230, Laws of 1974. Title II, Department of Health, Chapter 58, Solid Waste Management Control Regulations, November 1981.	All infectious waste must be treated or otherwise rendered safe before disposal. Double bagging is considered a means of rendering an untreated waste safe.	Air and Solid Waste Permit Section Department of Health Amelco Building, 3rd Floor 645 Halekau Wila Street Honolulu, Hawaii 96313

APPENDIX (Continued)

State	Statutory Authority and Regulation Citation	Summary of Requirements	State Agency
Idaho	Idaho Code, Title 39, Chapter 1. Idaho Solid Waste Management Regulations, Title I, Chapter 6.	All solid waste must be managed to prevent health hazards, public nuisances, and pollution of the environment during treatment, storage and disposal. Policy is to recommend that infectious waste be double bagged prior to disposal.	Hazardous Materials Bureau Department of Health and Welfare State House Boise, Idaho 83720 (208) 334-4107
Illinois	Illinois Revised Act 101-105, January 1985. State of Illinois Rules and Regulations 35, Subtitle G, Subpart F, Sections 700.601-700.605	All infectious hospital waste must be rendered innocuous by sterilization or incineration before disposal.	Division of Land Pollution Control Environmental Protection Agency 2200 Churchill Road Springfield, Illnois 62706 (217) 782-6762 or 782-6760

State	Statutory Authority and Regulation Citation	Summary of Requirements	State Agency
Indiana	Indiana Code, Title 13, Article 7, Environmental Management Act.	The state has statutory authority to regulate infectious waste as a hazardous waste but has not yet promulgated regulations. Regulations are being drafted.	Division of Land Pollution Control State Board of Health 1330 West Michigan Street, Rm A304 Indianapolis, Indiana 46206 (317) 243-9100
	Refuse Disposal Act: recodified as Indiana Solid Waste Disposal Law IC-36-9-30. Rule 330 IAC 4.	Written approval must be obtained before disposal of infectious waste in a sanitary landfill.	
Iowa	Iowa Code 1985, Section 455B.304. 900--100.3(2) Iowa Administrative Code (IAC)	Land disposal of infectious waste is prohibited unless a special waste authorization is granted that requires autoclaving or formalin treatment before land disposal.	Air and Waste Permit Branch Program Operations Division Iowa Department of Water, Air and Waste Management Henry A. Wallace Building 900 East Grand Street Des Moines, Iowa 50319 (515) 281-8692

State	Statutory Authority and Regulation Citation	Summary of Requirements	State Agency
Kansas	Kansas Statutes Annotated, Chapter 65, Article 34, as amended. Kansas Administrative Regulations, Title 28. Public Health, Article 29, Regulation 27, Effective May 1984.	Infectious waste must be incinerated, treated before land disposal, or ground to the sewer. Untreated infectious waste may be sent to a hazardous waste land disposal facility or to a sanitary landfill with authorization from the Department.	Solid Waste Management Section Department of Health and Environment Forbes Field, Building 321 Topeka, Kansas 66620 (913) 862-9360, Ext. 309
Kentucky	Kentucky Revised Statutes, 224.005(227)(a).	The state has statutory authority to regulate infectious waste as a hazardous waste but has not yet promulgated regulations.	Division of Waste Management Cabinet of Natural Resources and Environmental Protection 18 Reilly Road Frankfort, Kentucky 40601 (502) 564-6716
	Certificate of Need and Licensure Law, as revised, (originally effective January 1, 1973). 902 Kentucky Administrative Regulations, 20:009, Hospital Facility Regulation.	Hospitals must have an incinerator capable of destroying infectious waste. Hospitals which satisfy the treatment, packaging, and transportation requirements can secure waivers to incinerate the waste in city facilities. Revised regs effective 6/4/85 require that sharp waste (needles, glass, etc.) be separated from other infectious waste. Sharp waste is to be packaged in rigid containers for either incineration or disposal in approved landfills.	Division for Licensing and Regulation Department of Human Resources 275 E. Main Street Frankfort, Kentucky 40601 (502) 564-2800

State	Statutory Authority and Regulation Citation	Summary of Requirements	State Agency
Louisiana	Louisiana Revised Statutes, Act 449, 30: 1133, Environmental Affairs Act.	The state has statutory authority to regulate infectious waste as a hazardous waste but has not yet promulgated regulations. Policy is to allow disposal of treated infectious waste in selected sanitary landfills.	Hazardous Waste Division Department of Natural Resources P.O. Box 44066 Baton Rouge, Louisiana 70804 (504) 342-1216
Maine	Title 38 of Maine Revised Statutes Annotated.	The state has statutory authority to regulate infectious waste as a hazardous waste but has not yet promulgated regulations.	Bureau of Oil and Hazardous Waste Materials Department of Environmental Protection State House -- Station 17 Augusta, Maine 04333 (207) 289-2651
Maryland	Annotated Maryland Code, Health Environment Article, Sections 9-210(g) and 9-229, effective July 1, 1984. Amended Guidelines for the Disposal of Infectious Waste, effective July 1, 1984.	Infectious waste cannot be disposed of in a landfill. Incineration is the preferred method of treatment.	Air Management Administration Department of Health and Mental Hygiene 201 West Preston Street, 2nd Floor Baltimore, Maryland 21201 (301) 225-5260

State	Statutory Authority and Regulation Citation	Summary of Requirements	State Agency
Massachusetts	Massachusetts General Laws, Chapter 111, Subsections 3 and 51-56, and Chapter 111D. 105 CMR 130.354. Hazardous Infectious Waste Disposal Regulations; and 105 CMR 180.275, Regulation for Disposal of Infectious Materials from Independent Laboratories. Massachusetts General Laws, Chapter 21-C.	Infectious waste must be incinerated or treated before disposal.	Massachusetts Department of Public Health 150 Tremont Street Boston, Massachusetts 02111 (617) 727-2700
	Massachusetts General Laws, Chapter 21-C.	The state has statutory authority to regulate infectious waste as a hazardous waste but has not yet promulgated regulations.	Division of Solid and Hazardous Waste 1 Winter Street Boston, Massachusetts 02108 (617) 292-5582
Michigan		As of December 28, 1985, Michigan deleted its list of infectious wastes from the regulations.	Office of Hazardous Waste Management Michigan Department of Natural Resources P.O. Box 30038 Lansing, Michigan 48909 (517) 373-1220

APPENDIX (Continued)

State	Statutory Authority and Regulation Citation	Summary of Requirements	State Agency
Minnesota	Minnesota Statutes Annotated Chapters 115A and 116, Enacted by Laws of 1980, as amended. Minnesota Code of Agency Rules, Title 6, Part 4, as amended SW1-12 and SW6-2viii.	Land disposal of infectious waste is prohibited.	Division of Solid and Hazardous Waste Minnesota Pollution Control 1935 West County Road B-2 Roseville, Minnesota 55113 (612) 296-7373
Mississippi	No laws or regulations pertaining to infectious waste management.		Division of Solid/Hazardous Waste Management Bureau of Pollution Control Department of Natural Resources P.O. Box 10385 Jackson, Mississippi 39209 (601) 961-5171
Missouri	Missouri Hospital Licensing Law, Chapter 197 of Missouri Revised Statutes, Rules and Regulations for Hospitals.	Infectious waste generated by hospitals must be either incinerated or autoclaved before being sent to a landfill permitted to accept the waste. Waste is required to be treated on site. The state expects to revise regulations later this year.	Missouri Department of Health Bureau of Hospital Licensing P.O. Box 570 Jefferson City, Missouri 65102 (314) 751-2713

APPENDIX (Continued)

State	Statutory Authority and Regulation Citation	Summary of Requirements	State Agency
Missouri	Missouri Hazardous Waste Management Law, Chapter 260 of Revised Statutes of Missouri, 1985, as amended.	The state has statutory authority to regulate infectious waste as a hazardous waste but has not yet promulgated regulations.	Waste Management Program Department of Natural Resources P.O. Box 176 Jefferson City, Missouri 65102 (314) 751-3241
	Missouri Solid Waste Management Law, Chapter 260.200 of Revised Statutes of Missouri, 1975. Missouri Solid Waste Management Rules and Regulations, 10CSR80, Chapters 1-5.	Sterilized infectious waste may be disposed of in any permitted solid waste landfill.	
Montana	Montana Solid Waste Management Act of 1976. Administrative Rules of Montana, Title 16, Chapter 14, Subchapter 5, Solid Waste Management/Refuse Disposal.	Policy is to recommend treatment of infectious waste before land disposal.	Solid and Hazardous Waste Management Bureau Department of Health and Environmental Sciences Cogswell Building, Rm B201 Helena, Montana 59620 (406) 444-2821
	Montana Hazardous Waste Act of 1981.	The state has statutory authority to regulate infectious waste as a hazardous waste but has not yet promulgated regulations.	

APPENDIX (Continued)

State	Statutory Authority and Regulation Citation	Summary of Requirements	State Agency
Nebraska	Nebraska Environmental Protection Act, Section 81-1501 through 81-1540.	The state has statutory authority to regulate infectious waste as a hazardous waste but has not yet promulgated regulations.	Land Quality Division Department of Environmental Control State House Station P.O. Box 94877 Lincoln, Nebraska 68509 (402) 471-2186
Nevada	Nevada Revised Statutes, Chapter 459, Hazardous Waste Disposal and Solid Waste Disposal. Regulations Governing Solid Waste Management, Effective 1977.	The state has statutory authority to regulate infectious waste as a hazardous waste but has not yet promulgated regulations. Infectious waste generated by hospitals may be placed in a land disposal facility only under approval of the Department.	Division of Environmental Protection Department of Conservation and Natural Resources Capital Complex Carson City, Nevada 89710 (702) 885-4670

APPENDIX (Continued)

State	Statutory Authority and Regulation Citation	Summary of Requirements	State Agency
New Hampshire	New Hampshire Revised Statutes Annotated 151, 1979. Health Facilities Rules and Regulations, effective February 1984. General Requirements For all Facilities, HEP-801.	Infectious waste generated by health care facilities must be incinerated.	Bureau of Health Facilities Administration Division of Public Health Department of Health and Welfare 6 Hazen Drive Concord, New Hampshire 03301 (603) 271-4592
New Jersey	New Jersey Statues Annotated, Title 13: Conservation and Development, Chapter 1E-1. New Jersey Administrative Code, Title 7, Chapter 26, as amended. New regulations dealing with hazardous wastes expected within the year.	Infectious waste must be rendered non-infectious in accordance with the standards of the New Jersey Department of Health.	Division of Waste Management Department of Environmental Protection 33 East Hanover Street Trenton, New Jersey 08625 (609) 292-9877
	New Jersey Health Care Facilities Planning Act. New Jersey Administrative Code 8:43-B-3.6.	All infectious waste generated by hospitals must be treated before land disposal. Infectious waste that is not autoclaved or incinerated can be double-bagged for land disposal by a method approved by the Department of Environmental Protection.	New Jersey Department of Health Division of Health Facilities Evaluation CN 370 Trenton, New Jersey 08625 (609) 292-7834

APPENDIX (Continued)

State	Statutory Authority and Regulation Citation	Summary of Requirements	State Agency
New Mexico	Hazardous Waste Act, Section 74-4-3, as amended through 1981.	No specific regulations on infectious waste. Incineration or sterilization of infectious waste followed by land disposal is recommended.	Solid and Hazardous Waste Management Programs Health and Environment Department P.O. Box 968 Santa Fe, New Mexico 87504-0968 (505) 827-5271 or 827-0020
New York	Environmental Conservation Law, Article 27. Title 6 NCRR part 364. Collection and Transport of Industrial, Commercial, and Certain Other Wastes.	Anyone transporting a hospital waste off-site (including infectious waste) must have a waste transporter's permit.	Division of Solid and Hazardous Waste Department of Environmental Conservation 50 Wolf Road, Room 417 Albany, New York 12233 (518) 457-3254
North Carolina	North Carolina Solid and Hazardous Waste Act, as revised, July 1983. 10 NCAC 10G, Solid Waste Management, July 1, 1985	Infectious waste must be treated by an approved method prior to disposal in a landfill.	Solid and Hazardous Waste Management Branch Division of Health Services Department of Human Resources P.O. Box 2091 Raleigh, North Carolina 27602 (919) 733-2178

State	Statutory Authority and Regulation Citation	Summary of Requirements	State Agency
North Dakota	No governing statute or regulations.	Policy is to require autoclaving or incineration of all infectious waste generated by hospitals and nursing homes. No untreated infectious waste may be disposed of in a landfill. Every hospital and nursing home must have access to a double-chambered, approved incinerator in order to be licensed.	Division of Health Facilities Department of Health State Capitol Building Bismark, North Dakota 58505 (701) 224-2352
Ohio	Ohio Revised Code, Title 37, Chapter 34, as amended. Ohio Administrative Code, Regulations 3745-27 and 3745-37, Effective July 29, 1976.	The state has statutory authority to regulate infectious waste as a hazardous waste but has not yet promulgated regulations.	Division of Solid and Hazardous Waste Management Ohio Environmental Protection Agency 361 East Broad Street Columbus, Ohio 43215 (614) 466-7220

APPENDIX (Continued)

State	Statutory Authority and Regulation Citation	Summary of Requirments	State Agency
Oklahoma	Oklahoma Statutes, Title 63, 1981, Section 1-2001 et seq., Oklahoma Controlled Industrial Waste Disposal Act.	The state has statutory authority to regulate infectious waste as a hazardous waste but has not yet promulgated regulations. Current policy is based on CDC guidelines. Infectious waste regulations are being drafted.	Institutional Services, Medical Facilities Department of Health P.O. 53551 1000 N.E. 10th Street, 4th Floor Oklahoma City, Oklahoma 73152 (405) 271-6811
Oregon	Oregon Revised Statutes, Chapter 459, as amended. Oregon Administrative Rules, Chapter 340, Division 61.	Land disposal of infectious waste is controlled through the permitting process for land disposal facilities.	Hazardous and Solid Waste Division Department of Environmental Quality P.O. Box 1760 Portland, Oregon 97207 (503) 229-6266
Pennsylvania	Pennsylvania Statutes, 62 PS 901-1059, Public Welfare Code. Pennsylvania Code, Title 28, Chapter 147.74, Pennsylvania State Health Department Regulations: Disposal of Bacterial and Pathological Wastes That Are Generated in Hospitals and Medical Care Facilities.	Current policy is to allow off-site sterilization of infectious waste. New regulations are being drafted.	Bureau of Waste Management Department of Environmental Resources Fulton Building 8th Floor P.O. Box 2063 Harrisburg, Pennsylvania 17120 (717) 787-6239

State	Statutory Authority and Regulation Citation	Summary of Requirements	State Agency
Rhode Island	Rhode Island Hazardous Waste Management Act of 1978. Hazardous Waste Rules and Regulations Effective December 20, 1979. Rules and Regulations for Hazardous Waste Generation, Transportation, Treatment, Storage and Disposal - Effective July 18, 1984.	Infectious waste is regulated as a hazardous waste.	Division of Air and Hazardous Materials Department of Environmental Management 204 Cannon Building 75 Davis Street Providence, Rhode Island 02908 (401) 277-2797
South Carolina	Code of Laws of South Carolina, 1976, Sections 44-56-10 through 44-56-140, Hazardous Waste.	The state has statutory authority to regulate infectious waste as a hazardous waste but has not yet promulgated regulations. The state recommends that infectious hospital waste be incinerated or otherwise treated before land disposal.	Bureau of Solid and Hazardous Waste South Carolina Department of Health and Environmental Control 2600 Bull Street Columbia, South Carolina 29201 (803) 758-5681

APPENDIX (Continued)

State	Statutory Authority and Regulation Citation	Summary of Requirements	State Agency
South Dakota	South Dakota Codified Laws, Chapter 34A-6-2, Solid Waste Disposal Act.	The state has statutory authority to regulate infectious waste as a hazardous waste but has not yet promulgated regulations.	Office of Air Quality and Solid Waste Department of Water and Natural Resources Joe Foss Building 523 East Capitol Avenue Pierre, South Dakota 57501 (605) 773-3153
Tennessee	Tennessee Hazardous Waste Management Act of 1977, as amended. Tennessee Solid Waste Disposal Act, as amended.	The state is initiating rulemaking action.	Division of Solid Waste Management Tennessee Department of Public Health and Environment Customs House, 4th Floor 601 Broadway St. Nashville, Tennessee 37219-5403 (615) 741-3424
	Tennessee Code Annotated, 6811-201 through 217 Minimum Standards and Regulations for Hospitals, 1974.	All infectious waste generated by hospitals must be incinerated in closed incinerators on elevated platforms.	Hospital Licensing Board 283 Plus Park Nashville, Tennessee 37210 (615) 367-6200

APPENDIX (Continued)

State	Statutory Authority and Regulation Citation	Summary of Requirements	State Agency
Texas	Revised Civil Statutes of the State of Texas Annotated, Article 4477-7 Texas Solid Waste Disposal Act; and Article 4477-1, Texas Sanitation and Health Protection Law, as amended. Texas Administrative Code 325.136(b)(1), Texas Department of Health, Municipal Solid Waste Management Regulations, effective July 1983, as amended.	Infectious waste is regulated as a special waste. Incineration is the preferred method of treatment. Untreated waste may be double bagged and disposed of in a Type I municipal landfill.	Bureau of Solid Waste Management Texas Department of Health 1100 West 49th Street, T601A Austin, Texas 78756 - 3199 (512) 458-7271
Utah	Utah Code Annotated, Title 26, Chapter 14, Utah Solid and Hazardous Waste Act, Effective June, 1981.	The state has statutory authority to regulate infectious waste as a hazardous waste but has not yet promulgated regulations.	Bureau of Solid and Hazardous Waste Department of Health P.O. Box 45500 Salt Lake City, Utah 84145-0501 (801) 533-4145

APPENDIX (Continued)

State	Statutory Authority and Regulation Citation	Summary of Requirements	State Agency
Vermont	Vermont Statutes Annotated, Title 10, Chapter 159. Hazardous Waste Management Regulations, as amended September 13, 1984, Section 6602(2)(a)(14).	Infectious waste is regulated as a hazardous waste.	Hazardous and Solid Waste Management Division Department of Water Resources and Environmental Engineering Agency of Environmental Conservation State Office Building Montpelier, Vermont 05602 (802) 828-3395
Virginia	Code of Virginia, Title 32.1, Chapter 6, Article 3. Virginia Regulations Governing Disposal of Solid Waste, April, 1971.	Infectious wastes are not regulated as hazardous wastes. Waste generators must have special permission to dispose of non-municipal waste. Rules do not preclude land disposal of untreated infectious waste.	Division of Solid and Hazardous Waste Management Department of Health Monroe Building, 11th Floor 101 North 14 Street Richmond, Virginia 23219 (804) 225-2667

State	Statutory Authority and Regulation Citation	Summary of Requirements	State Agency
Washington	Revised Code of Washington, Hazardous Waste Disposal Chapter 70.105.	The state has statutory authority to regulate infectious waste as a hazardous waste but has not yet promulgated regulations.	Hazardous Waste Section Department of Ecology Mail Stop PV-11 Olympia, Washington 98504 - 8711 (206) 459-6322
	Revised Code of Washington, Hospital Licensing and Regulation Statute, Chapter 70.41. Washington Administrative Code, 248-18-170, Hospital Rules and Regulations.	Infectious waste generated by hospitals must be incinerated or disposed of by other approved methods. Approved methods include autoclaving, retorting, or double bagging before land disposal.	Department of Social and Health Services Facility Licensing Certification Section of the Health Services Division Mail Stop ET-31 Olympia, Washington (206) 753-7039
West Virgina	Code of West Virginia, Chapter 20, Article SE, Effective July 7, 1981.	Infectious waste regulations are being drafted.	State Health Department 1800 Washington Street East Charleston, West Virginia 25305 (304) 348-2970

APPENDIX (Continued)

State	Statutory Authority and Regulation Citation	Summary of Requirements	State Agency
Wisconsin	Wisconsin Statutes Annotated, Chapter 144, as amended.	The state has statutory authority to regulate infectious waste as a hazardous waste but has not yet promulgated regulations.	Bureau of Solid Waste Management Department of Natural Resources P.O. Box 7921 Madison, Wisconsin 53707 (608) 266-2111
	Chapter NR 181, and guidance summary "Handling and Disposal of Pathological Waste."	Policy is to recommend incineration of infectious waste. Infectious waste which has been autoclaved or sterilized may be bagged and disposed of in an engineered landfill.	
Wyoming	No regulations pertaining to infectious waste management.		Solid Waste Management Program State of Wyoming Department of Environmental Quality Herschler Building 122 West 25th Street Cheyenne, Wyoming 82002 (307) 777-7752 Department of Health and Social Services Division of Health and Medical Services 4th Floor Hathaway Bldg. Cheyenne, Wyoming 82002 (307) 777-7121